

PLUMMER (E.M.)
Compliments of the writer

J. R. St. Fitz. M.D.

»: INTUBATION :«

WITH

AN ANALYSIS OF FIFTY CASES.

AN ESSAY

READ BEFORE THE ANNUAL MEETING OF THE

Maine Medical Association,

JUNE 4, 1896,

BY

EDWARD M. PLUMMER, M. D.,

CHARLESTOWN, MASS.,

Aural Surgeon to the Carney Hospital; Clinical Aural Assistant to the Massachusetts Charitable Eye and Ear Infirmary; Consulting Laryngologist to the Boston Dental College; Instructor Boston Polyclinic; Fellow of the Massachusetts Medical Society; Member of the Maine Medical Association;

Member of the American Medical Association.

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E S S A Y

The purpose of this paper is to awaken an interest in a comparatively new method of relieving dyspnœa, and also to present for your consideration an analysis of fifty cases of intubation in private practice. Where this interest has not been thoroughly established, it is necessary to take into account the claims and vantage of the older operation for the same purpose. I shall endeavor, therefore, to sketch briefly the history of tracheal operations for the relief of dyspnœa, to indicate the lines along which a comparison between tracheotomy and intubation should be made; to describe the technique of the new operation; to consider its own peculiar problems and difficulties; and to state my own experience in so far as that sheds light thereon.

If one were to search historical records for the first recorded operation upon the trachea for the mechanical relief of unremitting dyspnœa, one would have to consult some of our oldest medical literature. Prior to the beginning of Christianity, Asclepiades of Bithynia, it is said, won for himself a great reputation by his practice of tracheotomy in angina.

During the barbarism of the dark ages, when not only science, literature and art were submerged in the advancing waves of superstition and ignorance, but when even the slightest manifestation of intellect for the betterment of human conditions was, if not repressed, at least not stimulated, tracheotomy fell into disuse, and we do not hear of it again until the revival of learning in the fourteenth century, when it was performed at

various intervals with unfavorable results. Home, in 1765, was the first to recommend tracheotomy in croup. A successful operation was also performed by Bretonneau in 1825, and another by Trousseau in 1833. Through the latter's industry and careful attention to details, the operation was placed upon a firm basis, so that, although prior to 1850, owing to the infrequency of success, it had been regarded with doubt, yet it became established as a valuable addition to surgery.

Nevertheless, the unfavorable results ascribed to tracheotomy, together with the time required for its performance, and the shock and hæmorrhage attendant upon it, led an American surgeon, Joseph O'Dwyer, of New York, to devise the operation known as intubation. Says O'Dwyer, "If I had had one recovery in ten from tracheotomy, intubation would probably be still a thing of the future." Thus impressed with the insufficiency of the only method in vogue for relieving dyspnœa, Dr. O'Dwyer instituted experiments with a definiteness, and continued them with a persistence imparted only by a clear formulation of the end in view and the conditions of its achievement. It is by these characteristics, as well as by the ensuing successful results, that his labors are distinguished from the few preceding timorous suggestions of, and abortive attempts at intubation. We must not on this account, however, fail to notice and honor the first appearances of the idea.

Over two thousand years ago, the idea of inserting a tube into the throat to admit air to the lungs was conceived by Hippocrates. The suggestion of Hippocrates seems not to have been duplicated or expanded until Chaussier, in 1780, advocated the insertion of flexible tubes into the larynx in cases of laryngeal obstruction. The practicability of this proposition was demonstrated in 1801 by Dessault; in a case of œdema of the glottis he passed into the larynx a flexible catheter, which he allowed to remain two days, thereby saving the life of the patient. This device, however, did not come into general use. Although mention of the operation is made in literature by such observers as Ducasse, Finaz, Dieffenbach, Benoit and others, we do not

hear of any attempts to intubate the larynx until September, 1858, when Bouchut read before the Academy of Medicine in Paris a paper entitled "A New Method of Treatment of Croup by Tubage of the Larynx." In this paper he described the ill-adapted tubes he had devised and the manner of placing them in the larynx. It was, however, Bouchut who performed the first intubations; but his procedure, ridiculed and condemned by Trousseau, fell into disuse and was soon forgotten.

In 1885, Dr. O'Dwyer, after five years of careful experimentation, pursued without prior knowledge of what had been done, proposed his method, and described the ingenious instruments he had evolved. Although little more than a decade has elapsed since he first gave to the world this brilliant contribution to legitimate surgery, yet it has already been the means of bringing relief to thousands of suffering children throughout the civilized world.

While intubation has thus gained by its successes a certain prestige, it cannot be said that it has entirely supplanted tracheotomy. A delicate but necessary task confronts us in attempting to compare as to merit the two rival operations. The reason for instituting this comparison is obviously pressing; the conditions for both operations are the same, namely: laryngeal obstruction as evidenced by a croupy cough; continued depression of the suprasternal, supraclavicular, and intercostal spaces; together with the noticeable stridulous breathing. If these symptoms be present and progressive, it is high time that the dyspnœa be relieved by the creation of an artificial air-passage; otherwise, death directly by asphyxia is invited. But even if asphyxia do not ensue, the insufficient oxygenation of the blood, together with the exhaustion brought about by the continued straining for air, reacts in the most unfavorable way upon the vital powers, and seriously affects them in their struggle with the specific poison. Moreover, a third menace, due to the depleted state of the lungs, is the imminence of capillary bronchitis and pneumonia.

Tracheotomy and intubation are the only operations designed

to furnish a passage for the air into the lungs when the larynx is thus obstructed, and from the nature of the case it would seem that they are the only possible operations. Upon the development of the proper symptoms, the surgeon must resort to one operation or the other; it becomes incumbent upon him, therefore, to sum up the evidence in favor of each procedure; to base thereon a general judgment as to their comparative value; and, finally, to consider whether there be in any special case conditions warranting a reversal of the judgment for that case.

Inasmuch as the formal definitions of the two operations suggest the lines along which a comparison should proceed, the privilege of reviewing them is requested. The inquiries that arise can be answered, of course, only by performing and observing the operation as experiments.

Both tracheotomy and intubation make use of a rigid tube for establishing communication between the external air and the lungs. In intubation, however, the tube is inserted into the passage that is naturally provided for such connection, but which is blocked up by yielding membranous accretions; in tracheotomy, on the other hand, the tube is inserted into a new passage created by the knife.

With regard to tracheotomy, we may ask the following questions:

(1.) Are there any features pertaining to the technique of the operation, that are unsuited to the exigencies and usual conditions of the occasion?

(2.) What are the possible and likely consequences of the incision, and of the insertion and maintenance of a tube in the opening?

(3.) Are there any disadvantages in the creation of an unnatural air-passageway?

Under the first question we shall consider the time and light required, and the necessity of giving ether.

To a child in danger of suffocation, the element of time is of primary importance. After preparations for asepsis have been completed, a careful tracheotomy may require from ten to fifteen

minutes. While the time consumed in operating may be abridged, if the exigency be great, yet even by the most skilled this abridgment is attended with risk, especially if the trachea to be operated upon be imbedded in the plump neck of a young child. In short, it seems to me that the time necessary for a safe tracheotomy (and in that time I include the time consumed in asepticising) is so long that the confidence of the surgeon in the ability of that operation to meet *all* the exigencies of his practice is often shaken.

Again, light sufficient for so delicate an operation is too often lacking in the usual circumstances. The writer has a vivid recollection of performing a tracheotomy upon a young child, under the flickering light of a candle held in the unsteady hand of the child's father.

The bad feature connected with the administration of ether is that it irritates the bronchial and pulmonary mucous membranes, thus causing them to secrete abundant mucus. In the attempt to cough up this mucus, the dyspnœa is temporarily increased, and it is likely enough that the irritation invites a downward extension of the diphtheritic inflammation. The objection to substituting chloroform for ether is, that although it is rapid in its action and does not irritate the air tract, it may result in cardiac syncope.

The second inquiry, as to the complications that may arise from the incision, and from the maintenance of the tube in the opening, deserves the most careful study.

Hæmorrhage is always to be considered; the most careful efforts to avoid the contiguous blood-vessels are apt to be thwarted by the constant motion to and fro of the field of operation under the labored respiration. Instances are on record in which the carotid and even the innominate arteries have been wounded. A hæmorrhage usually causes more or less delay in opening the trachea. In this connection, also, it should not be forgotten that in an operation upon a child loss of blood is to be deprecated, and especially so, if he be suffering from a disease of germ origin.

From an *a priori* point of view it would seem not improbable that the insertion and maintenance of a tube in the aperture created by the incision might injure superficially, if not seriously, the exposed tissue and membrane with which it comes in contact. Ulcerations, due to the continued pressure and friction of the tube, while not frequent, are almost invariably mentioned by records covering a large number of cases. These ulcerations may be either in the wound itself, or in the posterior wall of the trachea at the place of contact with the distal extremity of the canula.

After a long wearing of the tube, granulations are apt to form, not only at the external orifice of the wound, but also in the trachea itself. Those in the trachea may occlude the natural passage so completely as to render it impossible to dispense with the canula until they have been removed.

Another contingency is the infection of the wound. It would seem that the wound in the condition in which it is left would present difficulties in the way of asepsis that are not amenable to the usual aseptic technique. Beside the entrance of sepsis from without, the invasion of the wound and adjoining skin by the diphtheritic inflammation is not an impossibility.

Immediately after the incision has been made, and the tube successfully inserted, the patient is liable to a shock that sometimes becomes an important factor in the prognosis of the disease.

We have raised the question as to whether there be any disadvantage in the creation of an unnatural air channel, from consideration of the fact that air entering the lungs naturally through the nasal channels is purified, warmed, and moistened in the passage. Bronchitis and pneumonia have been traced to the unfitness for respiration of the air thus admitted immediately into the lungs. The objection contained in this inquiry, however, may be removed, to a certain extent, if the air in the room in which the patient is confined can be heated to the proper temperature and supplied with sufficient moisture.

Finally, then, we may say of tracheotomy, that while it is a

demonstrated means of admitting air to the lungs without hindrance to deglutition, and thus of relieving dyspnœa, nevertheless it is attended with possibilities of danger, which may become more likely according as the skill of the surgeon is less. Certainly, if it be possible to restore the respiration through the natural passages by a bloodless operation, the creation of an open wound and the exposure of membrane immediately adjoining the seat of diphtheritic inflammation, appears to me, if not irrational and dangerous, at least, an unnecessary exhibition of a skill developed by a practice that perhaps was not so successful.

Historically, the objections to tracheotomy led to the attempt to restore respiration by a simpler procedure, which consists in maintaining the natural passage by means of a metal tube inserted in the larynx and trachea. That the larynx will not spasmodically eject a tube has been abundantly proved; the sudden irritation and reflex action caused by the entrance into it of a drop of water or a crumb of food is entirely absent in case a tube be fitted into it. Intubation is defined in the National Medical Dictionary as "the insertion and maintenance of a tube within the chink of the glottis." Whatever difficulties may lie in the path of this proposed procedure, and whatever consequences may attend it, a simple analysis of the definition shows that there can belong to it none of the unpleasant features that bring tracheotomy into question; the operation requires no incision, and accordingly is exempt from any of the dangers that might accompany the use of the knife.

A study of the technique contrived by Dr. O'Dwyer will obviate many of the difficulties the definition would suggest. We, therefore, venture to give a brief description of the operation as practiced at the present time.

It is presupposed that the surgeon, before attempting to intubate a living larynx, has rehearsed the operation many times on the cadaver, not confining his attention to one cadaver only, but extending his practice to a dozen or more. This practice should be executed under the guidance of a competent instructor. In

this way only can the operator hope to acquire the tactual skill so essential in the performance of this operation. The unfavorable results reported by some operators are no doubt due to a lack of skill in operating.



O'Dwyer's Intubation Instruments.

Familiarity with the appearance and utility of the introducer, extractor, mouth-gag, metal gauge or scale, tubes of various sizes with their proper obturators, is herein taken for granted, as they are accurately described in all text-books on modern surgery.

The patient should be enveloped from the neck down in a light blanket, in such a manner as to prevent interference of his hands or arms with the operation, and should be held upright in the arms of a nurse, who should restrain the legs of the child with her own. Having inquired the child's age, the physician selects to accord with it, by the aid of the scale, a tube which is already fixed upon its proper obturator. The obturator immediately screws tightly to the introducer. A mouth-gag is now inserted into the patient's mouth, on the left side, well back between the teeth; the head is held and the gag steadied by an assistant standing behind. Holding lightly in his right hand the introducer laden as we have shown, the physician faces the child and is ready for the insertion. He passes his left index finger into the fauces until it reaches the epiglottis, which he therewith elevates; the introducer is placed in its initial position with the handle vertical and close to the chest. The tube, which is horizontal and points in toward the pharynx, is passed quickly over the tongue until its distal extremity reaches the tip of the left index finger; the handle of the introducer is then raised in such a manner as to incline the tube downward and insert its extremity into the chink of the glottis; at the same instant, the finger-tip is slipped aside, and the tube is rapidly but gently lowered into its proper position. Immediately the slide of the introducer is shoved forward so as to release the hold of the obturator upon the tube, the index finger is placed upon the collar of the tube, and the obturator is withdrawn. Insertion in this manner need not, if skill be used, occupy more than eight seconds; if at the end of that period the tube be not in its correct position, it is better to withdraw it, and after a short rest make another attempt.

It should be mentioned here that no tube is properly equipped

unless it be provided with a fine thread, which, drawn through the hole in the collar, makes possible an easy removal in case the tube should accidentally slide into the œsophagus instead of into the larynx. When ease in breathing gives evidence that the tube has been properly placed, the thread should be withdrawn. Of course no precise time for wearing the tube can be specified; practically it should be worn as long as there exists a laryngeal stenosis. The judgment of the operator as to when the stenosis has sufficiently subsided to warrant extubation must be based on general symptoms.

Preparations for removal are the same as those for introduction; and the insertion of the point of the extractor into the orifice of the tube is accomplished by the same manœuvre as that by which, in introduction, the distal extremity of the tube was thrust into the chink of the glottis. Removal, however, is not so easy as introduction. The first difficulty consists in the likelihood of the point of the extractor to slide into the space between the tube and the laryngeal wall. If this misplacement occurs, the spreading of the beaks outside the tube may result in laceration of the laryngeal wall. If the walls be much torn, the tube is quite likely to slip into the trachea. Of course, if the guard screw of the extractor be properly set, the beaks can be spread for a distance but little greater than the diameter of the interior of the tube; even then, however, misplacement involves danger.

A second difficulty is usually experienced: a steady pressure maintained upon the lever of the extractor does not always prevent the beaks, when properly engaged within the aperture of the tube, from slipping and losing their grip. To overcome this difficulty, Dr. Edward H. Nichols, of Boston, has devised a special extractor.

It may safely be asserted that in extubation, as in all matters requiring delicate sensational discrimination and adjustment, practice is the fundamental pre-requisite. Hence every operator should prepare himself by many preliminary extubations per-

formed upon the cadaver. So much for the technique of the operation.

It has been asserted by some that intubation has certain objectionable features of its own that tend to counterbalance the defects of tracheotomy. I shall endeavor to embrace and consider the objections that seem to me most important in a somewhat methodical criticism of the operation; the scope of the criticism is suggested by the definition we have already cited, and indicated by the following questions:

(1.) What are the risks of insertion, and to what extent may these be nullified by technique?

(2.) Are there any bad effects made possible by the maintenance of the tube within the larynx for a considerable time?

As regards insertion, it must be remembered that until the tube is in its correct position, the obturator completely blocks its interior space; accordingly, during the period occupied by insertion, the passage of air is completely shut off. Is this period of sufficient duration to give the already weary patient a perceptible shock? I am convinced that if care and skill be used, such an event is only a remote contingency.

Let it be remembered, that while the left index finger holds the epiglottis, respiration need not be completely obstructed; then to incline, insert and lower the tube are adjustments that admit of so speedy, and withal so nice, an execution, that no shock need result. In but four of my cases, and those among the first ten, was a second attempt necessary; in two or three of the first cases the time consumed was somewhat over ten seconds; in no one of my last forty intubations did the bare insertion occupy more than eight seconds.

There are, however, other and more important risks involved in insertion, from the fact that the distal extremity of the tube must traverse the swollen interior of the larynx and trachea for a distance equal to the length of the tube. A pertinent question arises as to whether this movement may be brought about by so slight and successfully directed a force as to cause no injury to the tissue along which it takes place. It here be-

comes evident that a most essential presupposition of a successful insertion is a knowledge of the anatomy and internal shape and contours of the larynx and trachea. If the operator have this knowledge, and if through practice he has brought his hand to conform its movements to the picture in his mind, there is only a very slight possibility of his thrusting the tube into the soft tissues of the larynx. The false membrane that fills the passage readily yields under a slight pressure, so that the interior contours of the normal larynx remain a valid basis for work upon the diseased larynx. Indeed, the ventricles that in the normal larynx would tend to catch the end of the tube and cause it to diverge from its proper path are, in the diseased organ, filled in with masses of membrane.

The possibility of detaching portions of the false membrane and forcing them into a lower position than they would have occupied, seems to me the only contingency entirely unavoidable by a careful technique; and it is in dealing with this possibility that we must avoid the slightest appearance of dogmatizing. If the actual occurrence be other than very rare, it certainly constitutes a valid basis for opposing intubation, except in those circumstances that permit the patient to be watched by a trained eye with adequate closeness. Even if there be but a remote possibility of the occurrence, the assertion is thereby made good, that it would be better to have intubated patients placed together in a hospital where they can remain under the constant scrutiny of a physician and nurse. The danger of the occurrence lies, of course, in the fact that the membrane, when pushed down, is quite apt to cover the lower orifice of the tube, and thus produce, in a sudden and most startling manner, the death which the insertion is designed to avoid; the membrane may act as a valve, permitting inhalation, but shutting off exhalation. Let us consider this contingency under three headings:

(1.) How far may it be avoided by technique?

(2.) The manner of relieving the intense dyspnoea produced by its occurrence.

(3.) The testimony of recorded statistics with regard to the frequency of its occurrence.

How far may the contingency be avoided by technique? We answer, to a considerable degree, although not entirely; if the tube be inserted in conformity with the interior direction and structure of the passage, and if it be inserted with the gentlest possible pressure, there is obviously much less danger of the membrane's becoming detached and crowded down than there would be if the extremity of the tube were tentatively scraped in a nervous manner, first against one side of the organ and then against the other.

How may the produced dyspnoea be relieved? Immediate extubation is imperative, and when performed is usually followed by the expectoration of the membrane.

What and how valuable is the testimony of recorded statistics as to the degree of probability belonging to this contingency? We reply that the records of cases performed under the conditions of careful technique are invaluable here, because they constitute our only basis for estimating the importance of this possible accident as a ground for opposing intubation. Dr. Johann Bókai, Professor in the University of Budapest, in the *Jahrbuch für Kinderheilkunde und Physische Erziehung*, Leipzig, June 5, 1894, concludes from his own experience in five hundred cases, that pushing down the pseudo-membrane seldom occurs, and only in rare cases terminates fatally. Dr. V. Ranke, of Munich, the pioneer of intubation in Germany, also states from an extended experience that the likelihood of the occurrence has been greatly exaggerated. Says Dr. George McNaughton: "I can recall but three instances in 143 cases; it proved fatal in two cases; the patient in the other case recovered her breath and lived several days after." The accident has happened to O'Dwyer only three times, and then in his first 209 cases. Francis Huber, Dillon Brown, Waxham, Ganghofner, Baer, and Northrup, all emphasize the fact that this accident is of very rare occurrence. ^

We conclude, therefore, that inasmuch as the contingency we

In no one of the forty-seven intubations performed by the writer for the relief of acute laryngeal stenosis. Has there been any cause for alarm on this score.

have been discussing is of so rare occurrence, that since its bad effect may be stopped by extubation, it deserves very little weight as a general objection to the operation.

We come now to a consideration of the effects to be traced to the maintenance for a more or less extended period of the tube in the position it has acquired by insertion. Having in view the end of distinguishing and properly appreciating these effects, let us try to imagine what effects would occur, should the normal larynx be intubed, from complications that are due to the diseased condition of the larynx.

When it is remembered that the larynx is in juxtaposition with the organs of deglutition, and that to the act of deglutition there is necessary a definite muscular adjustment of the larynx, the performance of which might be termed its negative function, and that the strength of the muscles that accomplish this adjustment is nicely adapted to the unvarying weight of the organ to be moved, it becomes a pertinent inquiry as to what may be the effect of suddenly fitting into this organ a tube that may weigh anywhere from 4 to 15 grammes.

Experience has demonstrated that intubation usually interferes with deglutition to so considerable an extent that the tube is continued in the larynx with difficulty; food and drink, instead of passing over the glottis into the œsophagus, tend to slip through the tube into the trachea. Out of forty-seven intubated children, I found but nine who were able to sit up in bed and eat in the natural manner. Of these, but one was under five years of age; the rest were considerably above five. I may here give a general conclusion with regard to feeding intubated children; the younger the child the more difficult is the task of eating.

Aside from the immediate disagreeableness occasioned by the false passage of food, the fact that it renders imminent *Schluckpneumonie* forces the phenomenon into our most serious consideration. Just how pronounced the tendency would be were the tube inserted into the normal larynx, and just to what extent it is intensified when the larynx is burdened with pseudo-mem-

brane, it is difficult in the absence of the proper experiments to determine. Whether it be that the weight of the tube prevents the necessary elevation of the larynx, or whether motion of the epiglottis be hindered by the pressure and position of the collar of the tube, or whether the hindrance be due to some other cause obscured by our imperfect knowledge of the mechanics of deglutition, that the presence of the tube in the larynx constitutes in a majority of cases a distinct interference with the act of swallowing remains a fact, the significance of which for our purposes is not at all lessened by the lack of an adequate explanation.

It is a mistake, however, to hold up as an ideal of the surgical art an operation that is entirely unaccompanied by temporary inconvenience and positive disadvantage. Of no artificial invasion of the human organism, no matter how skillfully performed, can it be claimed that no restrictions attend it; the invasion is made for the purpose of producing some ulterior salutary effect, either upon the entire organism or one of its organs, and the accompanying restrictions are borne with, if possible, for the sake of the greater ulterior benefit.

Of course a temporary interference with deglutition by intubation must be considered in this light, provided that by reasonable effort the system may be supplied with a proper amount of food without entrance of a portion of it into the trachea. May this be accomplished, and how? The existence of this problem does not necessarily constitute an objection to intubation; rather, its solution forms a part of the *ensemble* of the operation; if a good solution do not exist, the operation must be condemned at once; if it do exist, it must be considered as a part of the operation, opposition to which must be on entirely different grounds.

We answer that the system may be supplied with food and the trachea protected from its intrusion in one of the four ways that follow:

First, by the Casselberry method. This method consists in placing the child in a position, the advantage of which was

made known by Dr. Casselberry, of Chicago; Dr. Casselberry discovered that by placing the child horizontally on its back and lowering its head from the plane of the rest of the body until the pharynx is on a lower plane than the larynx, deglutition takes place naturally and with comparative ease. When the head is in this position the force of gravity helps to carry the food safely past the glottis.

Whether the child eat in the erect or in the Casselberry posture, the food should be of a semi-solid consistency; under no circumstances should liquids be used, as they are apt to trickle into the tube and thus become a prolific cause of *Schluckpneumonie*.

I have made use of the following articles of food: custard, corn starch pudding, blanc mange, ice cream or sherbet, oranges, bananas, jellies of various sorts, together with solids, such as small cakes, cinnamon buns, bread, etc., soaked in milk or sherry wine.

My usual method has been to ascertain first whether the child could eat in the erect posture, and failing this to try the Casselberry position. I have resorted to the latter position successfully in thirty-two cases, and have failed to make it succeed in six cases.

For cases in which the Casselberry method does not prove effectual, there is open one of the three remaining methods.

Recourse may be had to rectal alimentation. My experience in rectal feeding proved very disappointing; not only did the necessary manipulation cause more or less exhaustion, but the rectum soon developed a tendency to repel the blandest injections. Nevertheless, in four of the six cases above mentioned, the only nourishment given was in the form of nutritious enemata. Among the articles of food used in this way were milk, eggs, bovine, extracts of beef, pure beef-juice, etc. The most satisfactory results were obtained from the use of milk peptonized by the addition of Fairchild's pepsin.

If rectal feeding be not feasible, we may resort to feeding the child through a stomach tube. This procedure, beside being

extremely disagreeable to the child, is apt to wound the throat and nose. To be fed properly in this manner the child should be seated upright in the lap of a nurse. A soft rubber catheter, well lubricated, is then introduced through the nose into the oesophagus; through this catheter milk is poured into the stomach. The physician should in all cases do this himself, unless he have the good fortune to be assisted by a nurse who has had previous experience in this procedure.

It was necessary for me to resort to this mode of feeding with but two patients, both of whom were between one and two years of age. The amount of nourishment given in this way will of course vary somewhat with the age and circumstances of the case; in my cases the usual amount given at a time was from three to four ounces. I have employed with great advantage Bryson Delavan's alimentation bottle. A flexible catheter of small size replaces the ordinary stomach-tube, and is introduced not into the stomach, but simply below the ^{laryngeal} constrictors.

Bókai has recommended the removal of the tube each time before the taking of food. In no case have I resorted to this method of feeding; the excessive manipulation of the diseased structures in and about the air-passages has been the ground on which I have avoided it.

It has been objected by Sajous, among others, that the tube may fail to remain in the position into which it has been placed, either by sinking further into the trachea or by being coughed up as a foreign body. Obviously this objection cannot be adequately considered until the tubes evolved by Dr. O'Dwyer have been made the subject of careful examination and study. The relevant facts are these:

(1.) The external conformation of the tube is studiously adapted to the internal conformation of the organ.

(2.) The size of the tube may be made to correspond accurately with the size of the larynx by the aid of the scale.

(3.) The collar of the tube, if properly selected, rests upon

the ventricular bands in such a manner as to form a mechanical barrier to further movement downwards.

(4.) The tube at its middle is provided with a swell that serves to tighten the clasp of the larynx upon it.

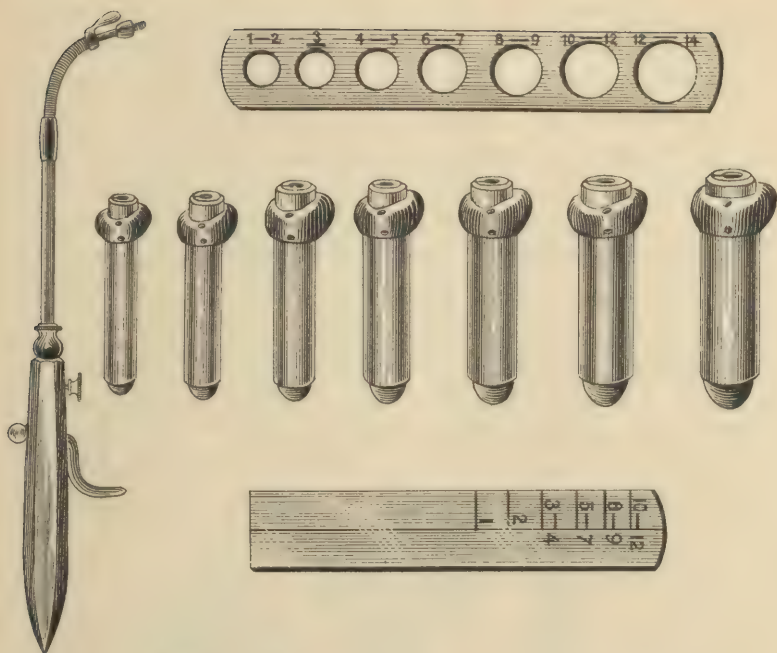
(5.) The weight and length of the tube are no inconsiderable factors in its ability to oppose the force involved in coughing.

In no case of mine has a tube failed to remain in its proper position.

It is possible, and in certain cases probable, that the tube may become gradually or suddenly occluded with mucus. Inasmuch, however, as the air that circulates through the intubation canula has usually been warmed and moistened by its passage through the nasal chambers, there is little probability, unless there be an extraordinary secretion, that the mucus will at any stage become dry, to such an extent that it will fail to yield to the current of air. If the patient breathes through the mouth and has a high temperature, especial care should be used to provide the room with abundant moisture. This may be accomplished either by the steam-atomizer, or, perhaps better, by means of a device contrived by Dr. Charles M. Whitney, and described by him in the *Boston Medical and Surgical Journal* for October 5, 1893.

In those cases in which an extraordinary secretion and flow of viscous mucus is observed, it is well to leave the thread attached to the canula, and to caution the attendant to watch the patient closely, and upon the manifestation of a pronounced dyspnoea, to remove the tube. For cases in which there is this flow of mucus, or in which there is much loose membrane in the trachea, a special tube has been devised by O'Dwyer. This tube is shorter, of larger caliber, has no retention swell, and is made in seven sizes. As it is more likely to be coughed up, the largest possible size should be used.

In five cases, I have met with this abundant secretion of mucus. In the first three cases I used the long tube, leaving the string attached and cautioning the attendant. In the third case, after the patient, a child between five and six, had been



O'Dwyer's Short Large Caliber Tubes.

intubated two days, the lumen of the tube became occluded by mucus of so tenacious a quality that apnœa resulted, from which the child died. Upon introducing the tube I had left a string attached. The parents, either from fright or stupidity, had failed to follow my explicit directions to remove the tube upon the manifestation of any serious difficulty in breathing. In the next case of this kind I first inserted the usual tube, and after an hour changed it for a short tube, which I allowed to remain two days; no ulcerations resulted, nor was it necessary to re-insert the long tube; the child recovered. In the fifth case, I inserted without delay a short tube, which after twenty-four hours I exchanged for a long tube. The latter was allowed to remain in the larynx for two days. No ulcerations occurred. The child recovered.

I have endeavored to make clear the most important conclu-

sions drawn from my own experience in intubation. These conclusions and the questions of technique and practicability to which they pertain have been, and it seems to me, advisably, isolated from any account of the cases based upon a consideration of the course of the specific diseases causing the stenoses. At the expense of repeating, it should be emphasized that intubation makes no attack upon the constitutional disease. I have, therefore, presented my experience merely with regard to the success and safety with which the operation may be made to accomplish its mechanical end of relieving dyspnœa.

Inasmuch, however, as I have, since taking up intubation, resorted in no case to the other operation, some determination of the scope of my experience seems necessary.

Of the fifty intubations, forty-seven were performed for the relief of acute laryngeal stenosis in children, while three were done for the relief of chronic stenosis in adults.

First, with regard to the forty-seven children. Of these thirty were males; with the exception of two cases, their ages were all between five and seven years; of the two cases, one was an infant of one year, while the other was a boy of ten years.

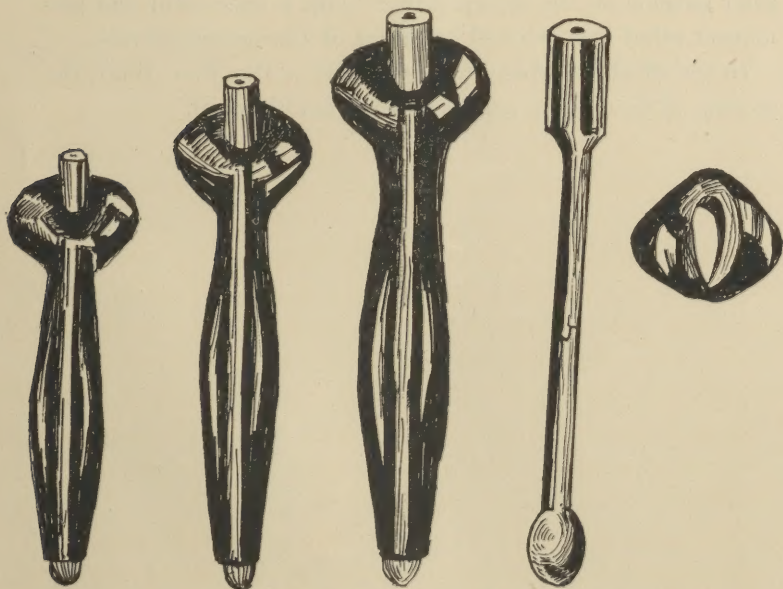
In eight cases the primary lesion was confined to the larynx, —the mucous membranes of the mouth, pharynx, soft palate and nasal passages remaining from the first, as far as I could judge, in a perfectly normal condition. With the treatment of these eight cases, together with one other in which the lesion was manifested first on the tonsils, I am familiar, as they came in my own practice; they were fortunate enough to come after the advent of antitoxine; all recovered.

The remaining thirty-eight cases were consultation cases, in which I attended simply to the tubeage. Without doubt they were characterized by radical variations in constitutional treatment, due as well to variations in judgment on the part of the physicians in charge as to the different times at which they occurred.

In thirty-one of the thirty-eight cases, the local manifestation first appeared over the tonsils and soft palate, and thence

extended to the larynx ; in all but two of these cases the downward extension ceased in the larynx ; in the two cases it extended from the larynx through the trachea into the ramifications of the bronchi, thereby producing broncho-pneumonia, from which both died. In three of the seven remaining cases the initial lesion was in the nasal passages, and extended thence to the adjoining mucous membranes of the pharynx and air-passages. Of the four remaining cases I have no record save that at the time of intubation the mucous membranes of the pharynx and air-passages were all invaded.

Of the twenty-eight deaths that took place among these forty-seven diphtheria cases, but one, in my judgment, can be traced either directly or indirectly to intubation. The circumstances of that case I have described.



Chronic Stenosis Tubes.

There remain to be considered three cases of chronic stenosis in adults. In two of these the stenosis was the result of the cicatrization of syphilitic ulcers ; in the other case the stenosis

was due to an œdema of the glottis that was a complication of Bright's disease.

In the cases of cicatricial stenosis, as no permanent improvement followed the use of the dilators of Mackenzie and Navratil, I resorted to continuous laryngeal pressure by means of O'Dwyer's probe-pointed, conical-shaped tubes. These were taken out, cleaned, and re-inserted every seven days through a period in the first case of about four months, and in the second of about three. In the first case, although the tube has been out for a year, no return of the stenosis has been reported. In the second case an occasional re-insertion has been necessary.

It is generally supposed that in œdema of the glottis, intubation can afford but slight relief on account of the swollen tissues overlapping the head of the tube. In the single case I report, after incision of the ary-epiglottic folds, a successful and permanent relief was attained by means of a large-headed tube.

In the effort to bring the essay within the time limit, the account of these cases has been somewhat abridged.

